# Pelagic Copepods from Kabira Bay, Ishigaki Island, Southwestern Japan, with the Description of a New Species of the Genus *Pseudodiaptomus*

By

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*With Text-figures 1–8 and Table 1*

**Abstract** Taxonomy and distribution of the pelagic copepods were investigated in Kabira Bay, Ishigaki Island. From the samples collected by vertical and oblique tows, 13 species of calanoids, eight species of cyclopoids and one species of harpacticoid were identified. A new species, *Pseudodiaptomus ishigakiensis*, and other little known species are described. *Acartia bispinosa, A. fossae* and *Oithona dissimilis* are firstly recorded in Japan. Distribution of the major copepod species shows that the hydrographic condition of the inner part of the bay is appropriate for the maintenance of neritic species, and oceanic species presumably cannot proliferate in the inner part of the bay.

Ishigaki Island, located at 24°20.7′N, 124°08.5′E, east of Formosa, is among the southernmost islands of the Ryukyu Archipelago. Although the copepod fauna in the East and South China Seas (Mori, 1937; Chiba, 1949; Chen & Zhang, 1965; Chen et al., 1974, etc.) and the water around Formosa (Tseng, 1970a, b) has been investigated in some details, nothing has been reported on the pelagic copepods in the embaymental waters of the Ryukyu Archipelago.

During 1975–1976, a plankton investigation was carried out in Kabira Bay, a small inlet on the northwestern coast of Ishigaki Island, as a part of a study on the coral-reef ecosystem (see Horikoshi, 1979, for a preliminary report). This paper reports some results of this investigation. An annotated list of pelagic copepods in Kabira Bay is presented together with the description of a new species of the genus *Pseudodiaptomus*. The distribution of the major copepod species is also described and discussed.

Samples were collected on 23 January and 9–10 June, 1975 and 22 October, 1976 at ten stations inside or outside Kabira Bay (Fig. 1). For convenience, these stations are grouped into three areas according to the topography of the bay: the embayment (Stns P2–P6), the waterway (Stns P8–P11) and the outside of the bay (Stns P12–P13). Collections were made in the daytime within one hour before and after high tides, although some of the stations in the waterway and outside the bay were omitted owing to the bad weather and strong current. At each station, plankton was collected by one or two vertical tows of a hand-towed net (23-cm mouth diameter, 40-$\mu$m mesh aperture) from the bottom to the surface. Additionally, oblique tows were made between the stations in the embayment (Stns P3–P4) and outside the bay (Stns P12–P13) to collect the less abundant species.

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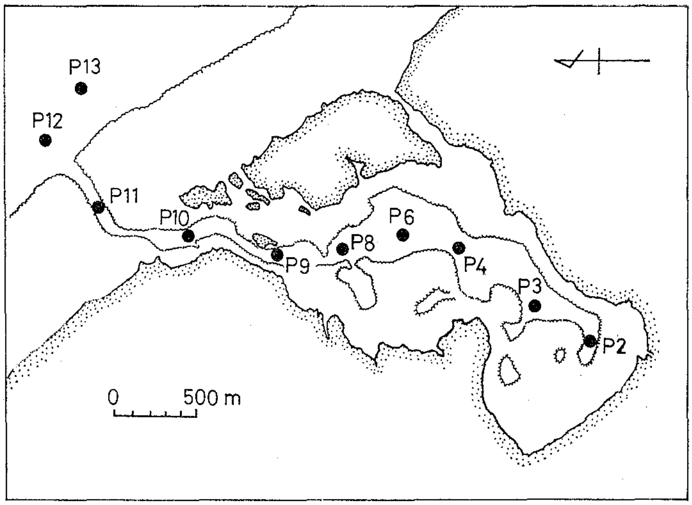


Fig. 1. Sampling stations.

The samples were fixed and preserved in 4% formaldehyde/seawater solution buffered with sodium tetraborate. In the vertical tows, the volume of water filtered was estimated by the mouth area of the net and the length of tow, assuming a 100% filtration efficiency. In the laboratory, large animals such as chaetognaths, decapod larvae and larger copepods (about 1 mm or more in length) were first sorted out, identified and counted. From the rest of the sample, ten 1/100-subsamples were obtained by a Stempel pipette, and copepods were counted and identified in a covered Sedgwick-Rafter cell (4-ml capacity, 4-mm depth) under a compound microscope. Both immature copepodid stages and adults were identified. The specimens which required an intensive observation were sorted out, stained with methyl blue, dissected and examined under a compound microscope. Drawings were made with the aid of a camera lucida.

## Annotated List of Pelagic Copepods in Kabira Bay

### Order Calanoida

### Family Calanidae

#### *Undinula vulgaris* (Dana, 1849)

*Undina vulgaris* Dana, 1849, p. 22.
*Calanus vulgaris*. —Giesbrecht, 1892, p. 92, pl. 6, fig. 11, pl. 7, figs. 2, 24, 27, pl. 8, figs. 17, 35.
*Undinula vulgaris*. —A. Scott, 1909, pl. 6.

OCCURRENCE. Stn P8, 22 Oct., 1976, 1 female.

### Family Paracalanidae

#### *Paracalanus* sp.

OCCURRENCE. Stns P3–P4, 10 June, 1975, 1 female.

*Remarks*. The length of the present specimen is 0.80 mm. The numbers of the teeth on the proximal outer margin of the third exopodal segment of the legs

2–4 are 9–10, 14 and 16–19, respectively. These characteristics agree with those of *P. parvus* f. *minor* described by Tanaka (1956). Bowman (1971) examined the specimens of *P. parvus* group off the southeastern United States and distinguished two species, *P. quasimodo* and *P. indicus*, which had been identified as *P. parvus* by the previous workers. This suggests that Japanese specimens which have been identified as *P. parvus* may be distinct from *P. parvus* or include species endemic to the Pacific. Further examination is necessary to solve this problem.

### *Paracalanus aculeatus* Giesbrecht, 1888

*Paracalanus aculeatus* Giesbrecht, 1888, p. 333; 1892, p. 164, pl. 9, figs 20, 26, 30.

OCCURRENCE. Stn P4, 23 Jan., 1975, 2 females.

### *Paracalanus crassirostris* (Dahl, 1894)

*Paracalanus crassirostris* Dahl, 1894, p. 12, pl. 1, figs 27–28. —Tanaka, 1960, p. 23, pl. 6, figs 1–7. —Chen & Zhang, 1965, p. 41, pl. 9, figs 1–6. —Wellershaus, 1969, p. 247, figs 1–9.
*Paracalanus crassirostris* f. *typica* Fruchtl, 1923, p. 456; 1924, p. 36.
*Paracalanus crassirostris* var. *nudus* Davis, 1944, p. 4, pls 1–2.
*Parvocalanus crassirostris*. —Andronov, 1970, p. 984. —Hiromi, 1981, p. 155, figs 1–2.

OCCURRENCE. See Fig. 7.

*Remarks*. Wellershaus (1969) listed the known forms of *P. crassirostris* on the basis of the marginal spinules on the exopods of female legs 2–4. In the present specimens (4 females), the third exopodal segments of female legs 2–4 have 4–5, 7–11 and 7–10 spinules on the proximal outer margin, respectively, and none on the distal margin. These characteristics are similar to those of *P. crassirostris* f. *typica* (Früchtl, 1923) and *P. crassirostris* var. *nudus* (Davis, 1944).

### *Acrocalanus similis* Sewell, 1914

*Acrocalanus similis* Sewell, 1914, p. 211, figs 3–5. —Wellershaus, 1969, p. 253, figs 10–20.

OCCURRENCE. Stns P3–P4, 10 June, 1975, 2 females.

## Family Calocalanidae

### *Calocalanus pavo* (Dana, 1849)

*Calanus pavo* Dana, 1849, p. 13.
*Calocalanus pavo*. —Giesbrecht, 1892, p. 175, pl. 1, fig. 13, pl. 14, fig. 15, pl. 9, figs 3, 4, 13, 19, pl. 36, figs 43–45.

OCCURRENCE. Stn P6, 10 June, 1975, 1 female.

## Family Clausocalanidae

### *Clausocalanus arcuicornis* (Dana, 1849)

*Calanus arcuicornis* Dana, 1849, p. 12.
*Clausocalanus arcuicornis*. —Frost & Fleminger, 1968, p. 46, figs 29–33.

OCCURRENCE. Stn P2, 23 Jan., 1975, 1 female.

### *Clausocalanus furcatus* (Brady, 1883)

*Drepanopus furcatus* Brady, 1883, p. 77, pl. 4, figs 1–2, pl. 24, figs 12–15.
*Clausocalanus furcatus.* —Frost & Fleminger, 1968, p. 76, pls 64–67.

OCCURRENCE. Stn P3, 23 Jan., 1975, 2 females.

## Family Centropagidae

### *Centropages* sp.

OCCURRENCE. Stns P3–P4, 10 June, 1975, 2 immature females.

## Family Pseudodiaptomidae

### ***Pseudodiaptomus ishigakiensis*, new species**

(Figs 2–4)

Material. Specimens were collected on 23 Jan., 1975 by an oblique net tow between Stns P3 and P4. Types are deposited in the National Science Museum, Tokyo (NSMT), and the National Museum of Natural History, Smithsonian Institution (USNM). Holotype, 1 female (NSMT-Cr 8684); allotype, 1 male (NSMT-Cr 8685); paratypes, 15 females and 10 males (NSMT-Cr 8686), 5 females and 8 males (USNM 213187).

Female: Total length 1.20–1.29 mm (holotype, 1.24 mm). Cephalothorax length 0.74–0.79 mm (holotype, 0.77 mm, measured from the anterior to posterior mid-dorsal margins of cephalothorax, Fig. 2a); width 0.35–0.38 mm (holotype, 0.37 mm).

Head rounded in dorsal view. Rostrum produced into 2 long filaments. Cephalosome and first thoracic segment separate; fourth and fifth thoracic segments fused. Fifth thoracic segment symmetrical; posterior corners produced into small spiniform processes. Proportional lengths of abdominal segments and caudal ramus 32.2: 14.8: 18.4: 11.6: 23.0; length to width ratios 1.4, 0.95, 1.2, 0.76 and 4.0. First to third abdominal segments each with row of triangular spinules on dorsoposterior margin; size of spinules increasing from first to third segments. Genital segment produced ventrally, slightly asymmetrical in dorsal view; dorsal surface with a few medial, transverse rows of very fine spinules; ventral surface with transeverse row of spinules anterior to genital area, a pair of fine setae near posterior margin. Lateral outer margin of caudal ramus divided into 4 portions (proportions of anterior to posterior portions 2: 2: 1: 1) by 2 small notches and base of lateral seta.

*First antenna* (Fig. 2e) length 1.2 times cephalothorax; 22-segmented; each segment except segments 6, 15, 16, 18–20 with aesthete; segments 6–7 incompletely fused, the former with short spine; segment 20 having specialized seta with small teeth on medial margin. *Second antenna* (Fig. 2f). Basal segment with 1 proximal, 2 medial and 2 distal outer marginal setae; expood with 7 terminal and 8 subterminal setae, and lateral fringe of fine hairs. Endopod 4-segmented; third segment inconspicuous and looking like membrane connecting second and fourth segments; first segment with 1 seta; second segment with 1 proximal, 2 medial and 1 terminal setae; third segment with 1 seta; fourth segment with 2 proximal, 1 medial and 3 terminal

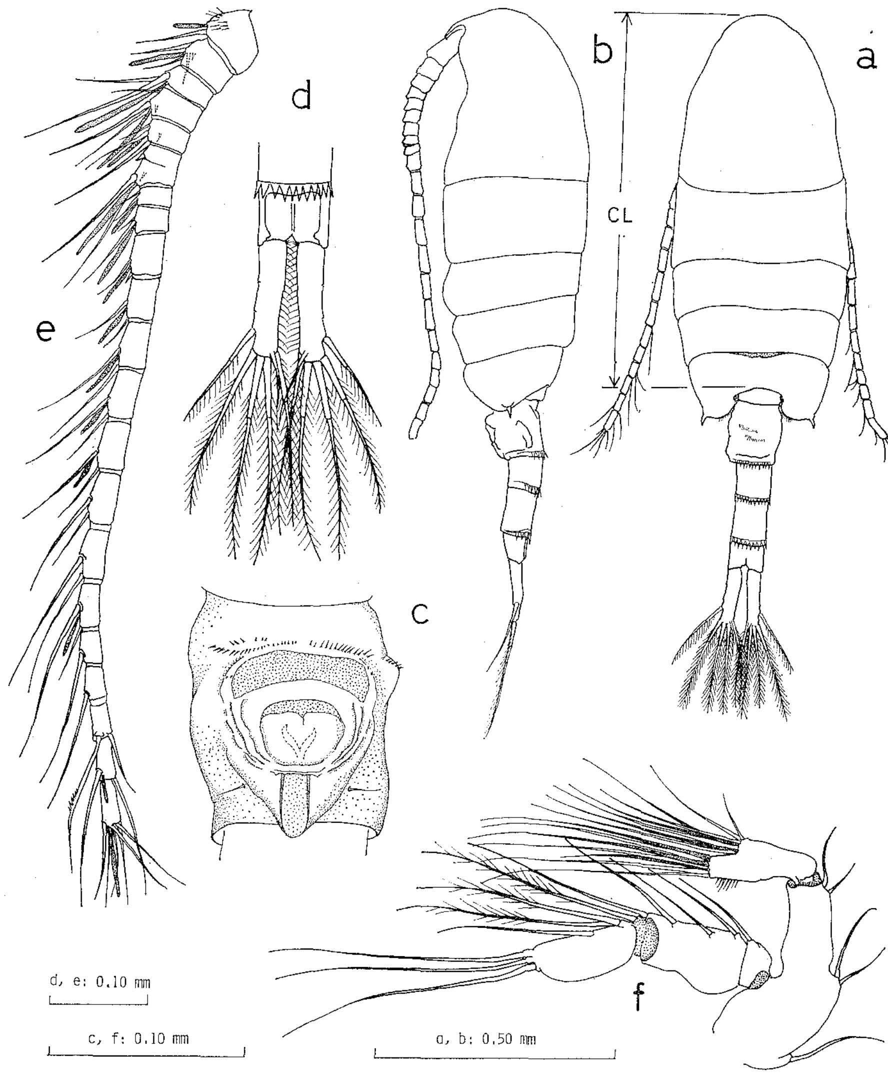


Fig. 2. *Pseudodiaptomus ishigakiensis* n. sp. Female: a, whole animal, dorsal view; b, whole animal, lateral view; c, genital segment, ventral view; d, anal segment and caudal rami, dorsal view; e, right first antenna, ventral view; f, second antenna. CL: cephalothorax length.

setae. *Mandible* (Fig. 3a). Basal segment of palp with 4 inner marginal setae. Exopod inconspicuously 2-segmented; proximal segment with 5, terminal segment with 8 setae and row of spinules on surface. Endopod with 6 setae; segmentation incomplete. *First maxilla* (Fig. 3b). Gnathobase with 9 strong and 2 finer spines; anterior surface with row and patch of spinules. Second and third inner lobes each with 4 terminal setae. Outer lobe with 7 long and 2 short setae. Exopod with 10 marginal setae. Endopod incompletely 3-segmented; first to third segments with 4, 4, and 7 setae, respectively. *Second maxilla* not examined. *Maxilliped* (Fig. 3c) 6-segmented; 2 basal segments large, 4 distal segments small. Setation as in Fig. 3c.

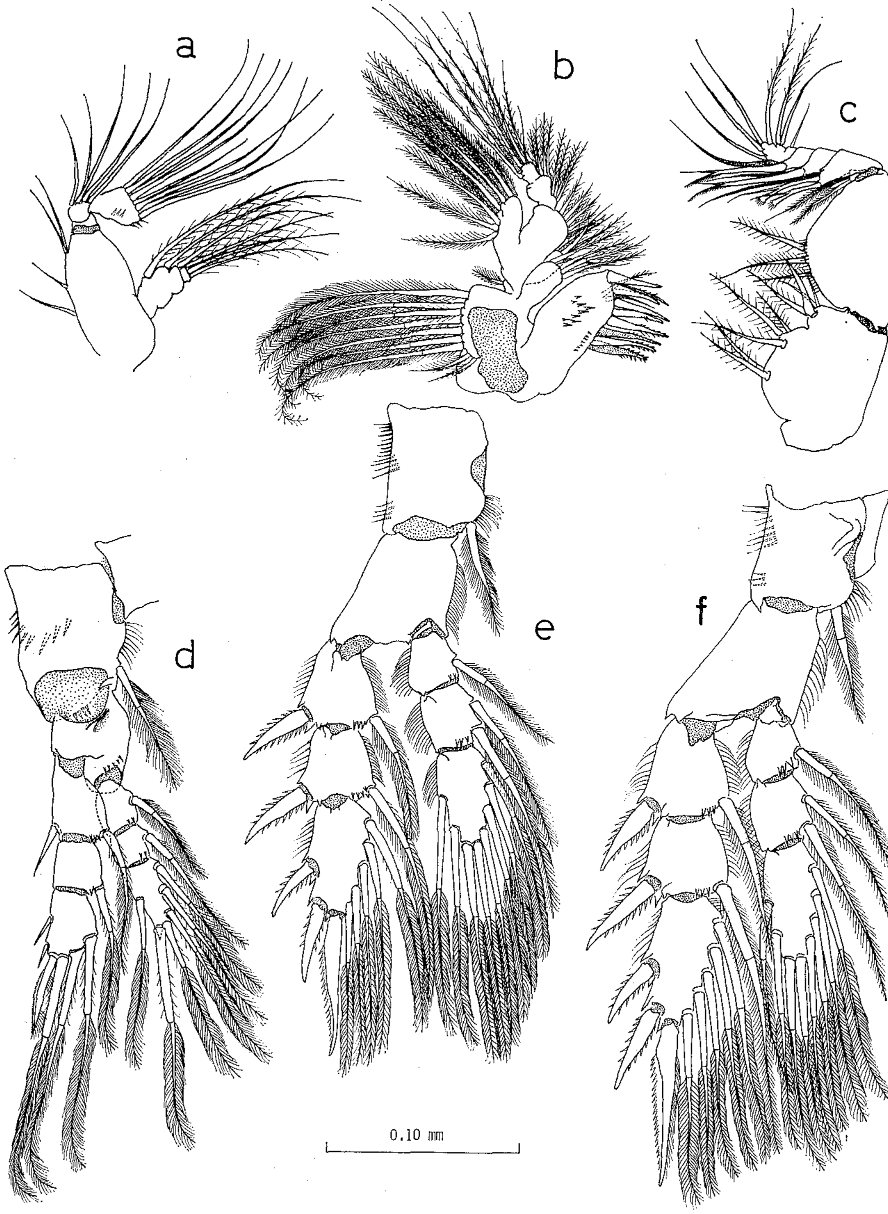


Fig. 3. *Pseudodiaptomus ishigakiensis* n. sp. Female: a, mandible; b, first maxilla; c, maxilliped; d, leg 1; e, leg 2; f, leg 3.

*Legs 1–4* (Figs. 3d-f, 4a) biramous, with 2 basal segments and 3-segmented exopod and endopod. First and second segments of both exopod and endopod of legs 1–3 with spinules on inner distal margin; only leg 4 with seta on second segment. Other spines and setae as in Figs. 3d-f and 4a.

*Leg 5* (fig. 4b) uniramous, 4-segmented and symmetrical; second segment, unlike *P. marinus* Sato, 1913 (Grindley & Grice, 1969; present observation), without

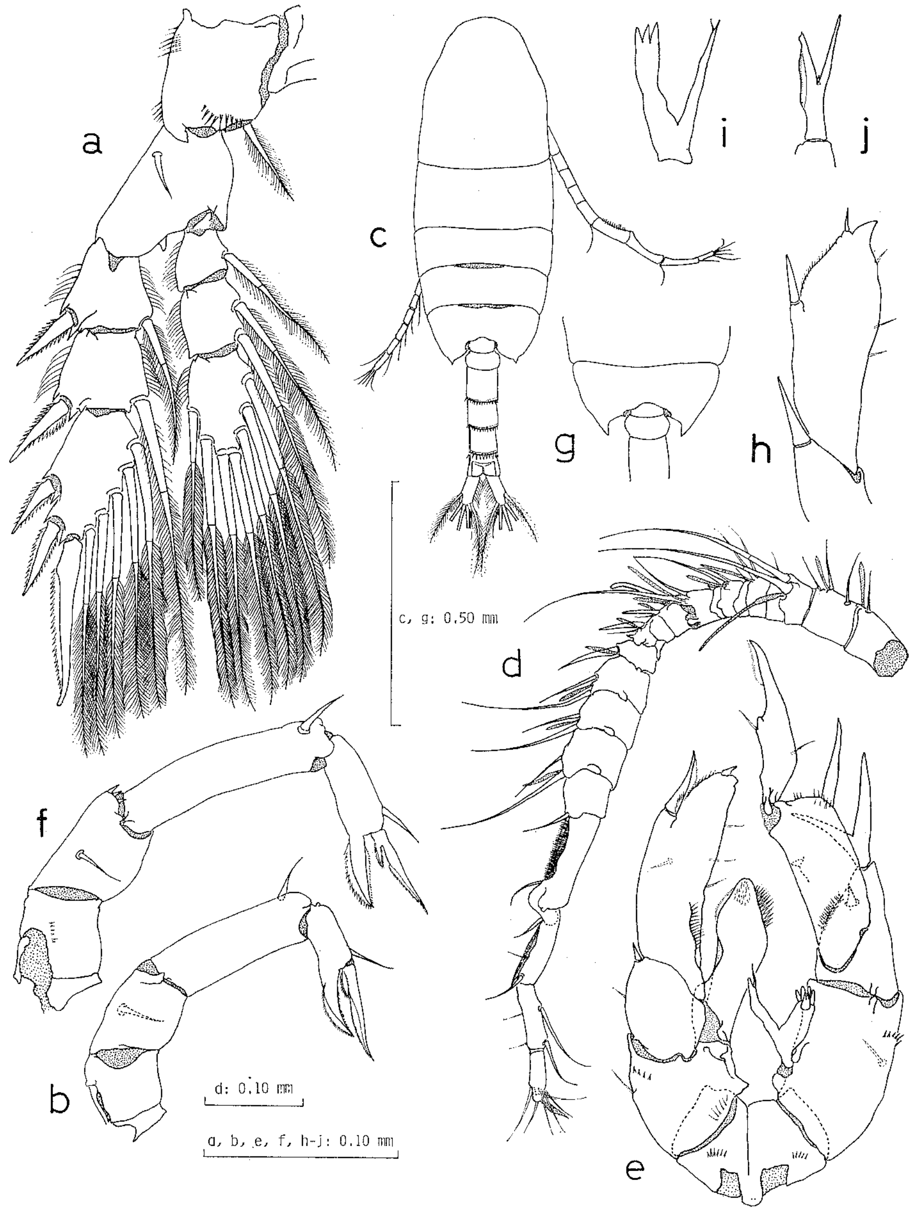


Fig. 4. *Pseudodiaptomus ishigakiensis* n. sp. Female: a, leg 4; b, leg 5. Male: c, whole animal, dorsal view; d, right first antenna, ventral view; e, leg 5. *Pseudodiaptomus marinus* from Hokkaido. Female: f, leg 5. Male: g, fifth thoracic segment, dorsal view; h, leg 5, left exopod; i, leg 5, right endopod; j, leg 5, Y-shaped spine on first segment of right exopod.

spinules on outer distal margin; third segment length 3.2 times width, with outer distal seta. Fourth segment with outer distal seta; inner distal part produced distally into curved spiniform process with serrate membrane on both margins; terminal

spine with teeth on distal half of inner margin, and short serrate spine near its base.

Male: Total length 1.01–1.05 mm (allotype, 1.04 mm). Cephalothorax length 0.65–0.68 mm (allotype, 0.67 mm, measured from the anterior to posterior middorsal margins of cephalothorax); width 0.29–0.31 mm (allotype, 0.30 mm).

Cephalothorax as in female. Proportional lengths of abdominal segments and caudal ramus 9.0: 20.2: 17.9: 17.6: 15.7: 19.6; length to width ratios 0.4, 1.0, 1.1, 1.1, 0.8 and 2.8. Second to fourth abdominal segments each with row of triangular spinules on whole posterior margin; the size of spinules increasing from second to fourth segments.

Appendages similar to female except right first antenna and leg 5. *Right first antenna* 21-segmented; seta and spines as in Fig. 4d.

*Leg 5* biramous, with 2 basal segments, 2-segmented exopod and 1-segmented endopod. First basal segment with row of spinules on anterior surface. Second basal segment with medial outer seta and distal outer row of spinules. First segment of right expod with row of spinules on inner margin, on distal end with V-shaped bifurcated spine without spinule in the fork; a little proximally to its base with short thick spinule. Second exopodal segment with long, straight naked spine on outer distal margin, and short thick spinule on posterior surface near medial point of inner margin; terminal hook with 1 inner and 1 outer midmarginal setae. Right endopod bifurcate; inner ramus slender and pointed, with fine seta near distal end; outer ramus thick and with 5 blunt distal spinules, one with teeth on tip. First segment of left expood with short naked spine on outer distal corner. Second segment with short terminal spine, and thick long outer spine with serrate membrane on inner margin; outer margin between these spines fringed with tiny spinules; inner margin with 3 fine setae distally, and row of setules proximally; 1 fine seta on medial posterior surface. Left endopod with patch of spinules on posterior surface near distal end, row of setules on distal inner margin, and serrate membrane on distal outer margin.

*Remarks*. *Pseudodiaptomus ishigakiensis* is distinguished from the closely allied species, *P. marinus* and *P. ardjuna* Brehm, 1953, in the following characters. (1) The spiniform processes on the fifth thoracic segment are smaller than in *P. marinus* (Fig. 4g) in both sexes. (2) The second segment of female leg 5, unlike *P. marinus*, lacks spinules on the distal outer margin; the third segment is thicker than in *P. marinus* (Fig. 4f). (3) The spiniform process on the fourth segment of female leg 5 is much more finely serrated on the medial margin than in *P. marinus*. (4) The first segment of the right expod of the male leg 5 has a V-shaped terminal spine, and there is no spinule in the fork; the homologous spine is Y-shaped in *P. marinus* and *P. ardjuna*; in *P. marinus* there is a spinule in the fork, and the inner margin of the inner ramus is modified into a blade-like thin membrane (Fig. 4j); in *P. ardjuna* (Brehm, 1953, Fig. 81; Pillai, 1970, Fig. 1m) one of the branch is much shorter than the other. (5) Right endopod of male leg 5 has five terminal spinules on the outer ramus; the homologous ramus has two to four points in *P. ardjuna* (Pillai, 1970,

Fig. 1m) and *P. marinus* (Grindley & Grice, 1969; Fig. 4i). (6) The first segment of the left expood of male leg 5 has a much shorter outer marginal spine than in *P. marinus* (Fig. 4h) and *P. ardjuna* (Brehm, 1953, Fig. 82; Pillai, 1970, Fig. 1m). (7) The outer marginal spine on the second exopodal segment of the left exopod of male leg 5 is long, extending beyond the tip of the terminal spine; the homologous spine is shorter in *P. marinus* (Fig. 4h). (8) In the male leg 5, the spine at the base of the forked spine on the first segment of right expod is much shorter than in *P. marinus*.

Grindley & Grice (1969) noted marked difference among the specimens of *P. marinus* collected from Mauritius, Japan and Hawaii, and the previous descriptions of *P. marinus*, especially in the right exopod and the forked spine on male leg 5, and the spine at the base of the forked spine. They considered that these differences do not indicate even subspecific differenciation, and might reprseent ecophenotypes. To examine the distinctiveness between *P. ishigakiensis* and *P. marinus*, I observed the specimens of *P. marinus* from Hokkaido (Nemuro Bay, collected by the Plankton Laboratory, Hokkaido University), Tokyo Bay (collected by the author), Seto Inland Sea (collected by S. Uye) and Kyushu (Ariake Bay, collected by R. Hirota). The differences between *P. ishigakiensis* and *P. marinus* in all the characters mentioned above were proved to be constant for all the above localities including Grindley & Grice's description of the specimens from Mauritius, and it is concluded that *P. ishigakiensis* is a species distinct from *P. marinus*.

## Family Parapontellidae

### *Neopontella typica* A. Scott, 1909

*Neopontella typica* A. Scott, 1909, p. 185, pl. 55, figs 1–15.

OCCURRENCE. Stn P4, 22 Oct., 1976, 1 female and 1 male.

## Family Acartiidae

### *Acartia bispinosa* Carl, 1907

(Fig. 5)

*Acartia bispinosa* Carl, 1907, p. 13, pl. 1, figs 1–2. —Grice, 1964, p. 261, figs 35–37.
? *Acartia tokiokai* Mori, 1942, p. 556, pl. 11, figs 1–18.
*Acartia hamata* Wilson, 1950, p. 152, pl. 2, figs 1–5.

OCCURRENCE. Stns P3–P4, 10 June, 1975, 5 females; Stns P12–P13, 10 June, 1975, 1 male.

Female: Distal corners of fifth thoracic segment produced into strong spiniform processes, each with small spine a little dorsally and medially, and a fine setule more dorsally. Posterior margin of genital segment with a pair of small spines dorsolaterally. Caudal ramus with transverse row of setules on dorsal surface. First segment of first antenna with 2 strong spines produced distally from anterior distal margin, with smaller spine near base of these spines; second segment with strong clawlike spine curving proximally from midposterior margin. Terminal segment of leg 5 length 2.4 times width: terminal spine slender, with finely serrated

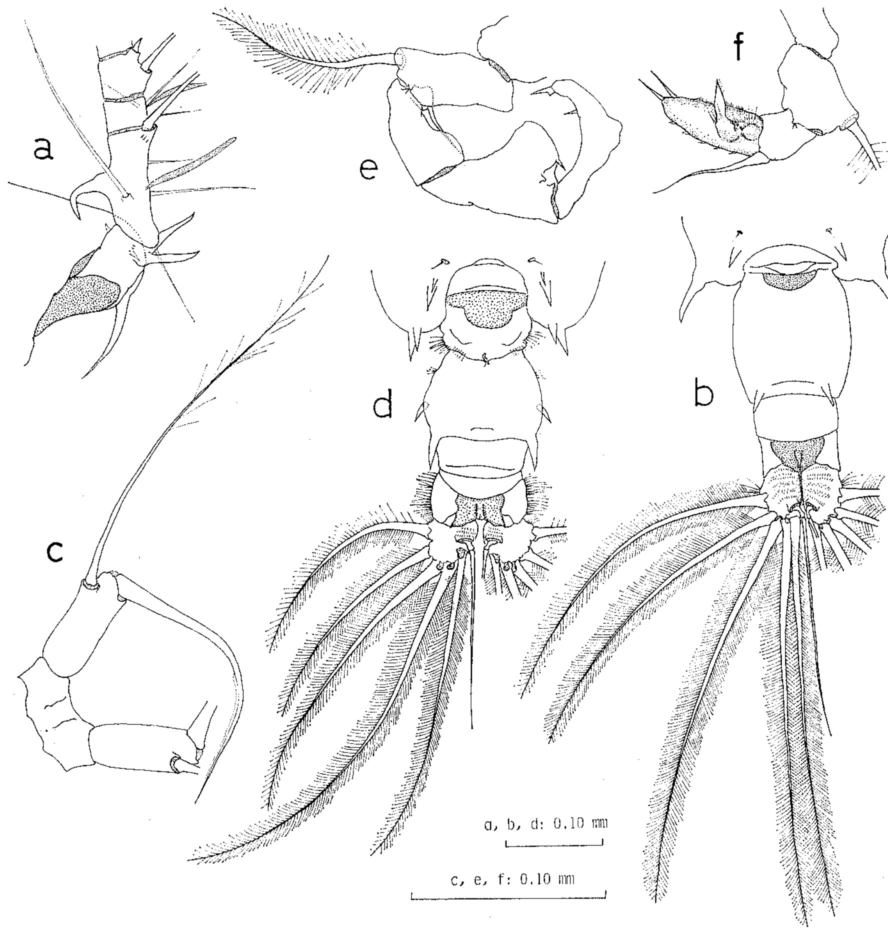


Fig. 5. *Acartia bispinosa*. Female: a, rostrum and first antenna, lateral view; b, fifth thoracic segment and abdomen, dorsal view; c, leg 5. Male: d, fifth thoracic segment and abdomen, dorsal view; e, right leg 5; f, left leg 5.

membrane on distal third.

Male: Posterior corners of fifth thoracic segment each with 2 subequal spines, dorsolaterally with 2 spines, one very small, and a fine setule more dorsally. First abdominal segment with rows of short hairs on lateral and posterior margins; second segment with tuft of hairs on anterior lateral surface, and a pair of small spines on ventrolateral side; posterior margin produced dorsolaterally into a pair of strong spiniform processes. Caudal ramus with transverse rows of setules at base of inner dorsal seta. Terminal segment of left leg 5 with 2 fine terminal spines, stout spine on midanterior surface with fine setae on its base, tuft of hairs proximal to the medial spine, row of spinules along inner margin, and several spinules along outer margin.

*Remarks*. *Acartia bispinosa* has been reported from Indonesia (Carl, 1907), Persian Gulf (Pesta, 1912), Sri-Lanka (Sewell, 1914), Seychells (Gianferrari, 1921,

1923), Gilbert Islands and Fiji Islands (Wilson, 1950) and presumably from Australia (Dakin & Colefax, 1940) and Palao (Mori, 1942; see Grice, 1964). This is the first record of *A. bispinosa* in Japan and may be the northernmost record in the Pacific.

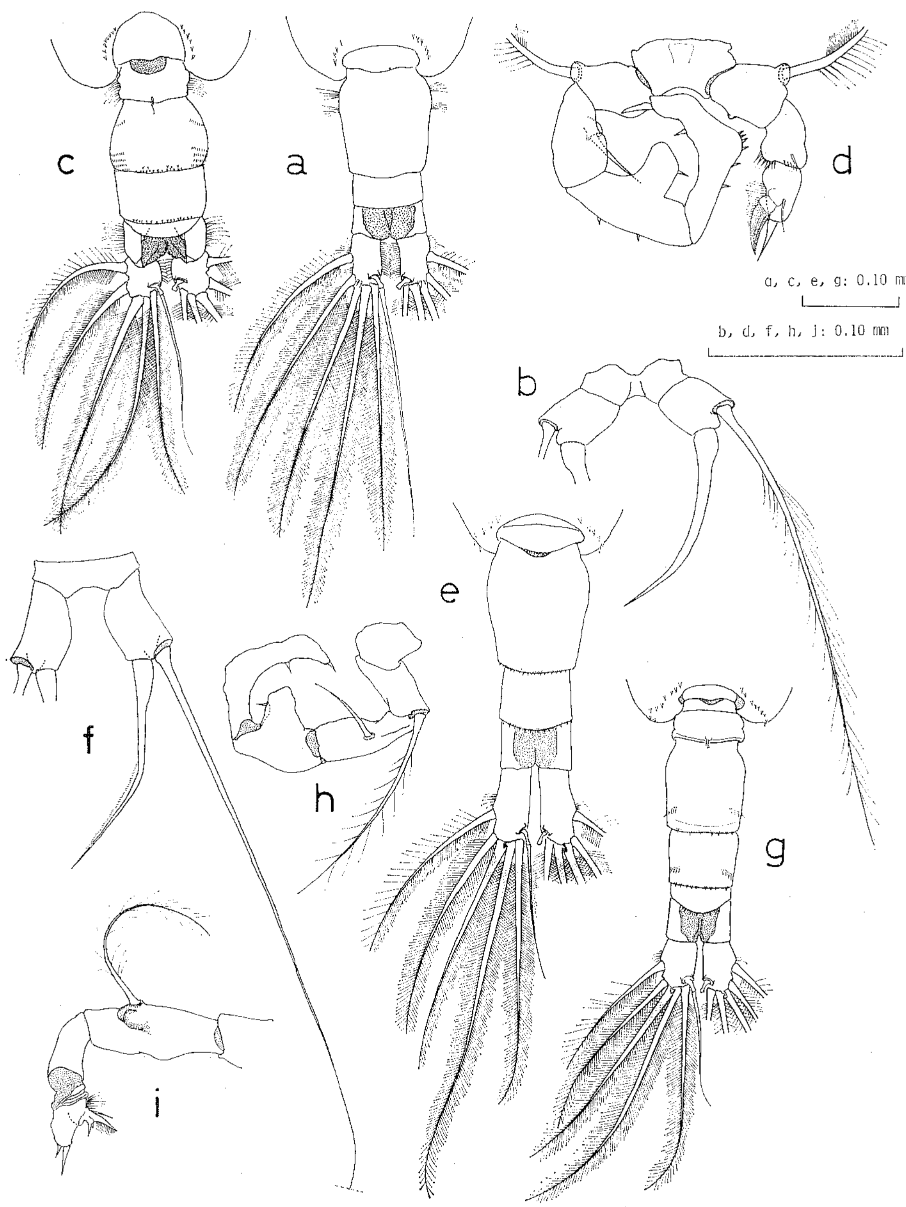


Fig. 6. *Acartia fossae*. Female: a, fifth thoracic segment and abdomen, dorsal view; b, leg 5. Male: c, fifth thoracic segment and abdomen, dorsal view; d, leg 5. *Acartia steueri*. Female: e, fifth thoracic segment and abdomen, dorsal view; f, leg 5. Male: g, fifth thoracic segment and abdomen, dorsal view; h, right leg 5; i, left leg 5.

### *Acartia fossae* Gurney, 1927

(Figs 6a-d)

*Acartia fossae* Gurney, 1927, p. 156, figs 22a–f. —Grice, 1964, p. 262, figs 38–40.
? *Acartia hamata* Mori, 1937, p. 104, pl. 51, figs 1–5; 1942, p. 555, pl. 10, figs 1–2.

OCCURRENCE. See Fig. 8.

Female: Fifth thoracic segment with row of spinules on dorsoposterior margin. Genital segment with 2 pairs of lateral tufts of hairs on anterior portion. Caudal ramus with dorsal spinules near base of outer terminal seta. Terminal segment of leg 5 nearly square; terminal spine swollen near its base, length about 0.5 times outer seta; terminal segment with small process between outer seta and terminal spine.

Male: Fifth thoracic segment with row of spinules on dorsoposterior margin. First abdominal segment with hair tufts on lateral margin. Second abdominal segment with dorsolateral rows of setules on medial and posterior portions. Second to fourth abdominal segments with rows of spinules on posterodorsal margin. Second segment of left leg 5 with fine seta near outer distal margin, and 2 rows of setules on inner distal margin and midanterior surface of distal margin; terminal segment with terminal spine thick and naked, 1 modified spine and 1 seta on midanterior surface; inner margin with row of fine hairs. The modified spine appears to be fringed on its outer margin with a row of setules or a thin membrane.

*Remarks*. *Acartia fossae* has been reported from the Suez Canal (Gurney, 1927), Tuamotu Islands (Vaissière, 1954) and Nosy-Bé (Binet & Dessier, 1968). The present record from Ishigaki Island which is located between the East China Sea near Amamioshima Island and Palao, where *A. hamata* has been reported by Mori (1937, 1942), supports the opinion of Grice (1964) that *A. fossae* and *A. hamata* may be conspecific.

### *Acartia steueri* Smirnov, 1936

(Figs 6e-i)

*Acartia steueri* Smirnov, 1936, p. 87, figs 1–3. —Brodsky, 1948, p. 75, pl. 25, figs 7–8, pl. 26, fig. 1. —Tanaka, 1965, p. 388, fig. 245.

OCCURRENCE. See Fig. 7.

Female: Fifth thoracic segment with row of spinules on posterior margin. First and seocnd abdominal segments with spinules on dorsoposterior margin. Length of terminal segment of leg 5 1.8 times width; outer seta long, length 4 times terminal spine; terminal spine swollen at its base, with finely serrated membrane on distal half of inner margin.

Male: Fifth thoracic segment with row of spinules on posterior margin. Second to fourth abdominal segments with spinules on dorsoposterior margin. Second and third abdominal segments each with a pair of ventrolateral rows of spinules near

posterior margin; second segment with or without a pair of ventral spinules near anterior margin. First segment of left leg 5 with protuberance on midanterior surface near base of outer seta. Terminal segment with 2 naked terminal spines, 1 strong spine produced inward from proximal inner margin with tuft of hairs on its proximal side, spine and seta at its base, and row of short hairs on outer margin.

*Remarks.* In the present specimens, the two ventral spinules on the second abdominal segment of the male described by Tanaka (1965) were present in some but absent in the others, and the presence of these spinules is considered variable even within a local population. *Acartia steueri* has been reported from the northern part of the Sea of Japan (Brodsky, 1948), the southern Kuriles (Kos, 1958), the Izu Region, Central Japan (Tanaka, 1965) and northern Kyushu (Ueda, 1980). This is the southernmost record of this species.

*Acartia erythraea* Giesbrecht, 1889

*Acartia erythraea* Giesbrecht, 1889, p. 26; 1892, p. 508, pl. 30, figs 5, 19, 32, pl. 43, figs 1, 7, 12–15.

OCCURRENCE. See fig. 7.

## Order Cyclopoida

### Family Oithonidae

*Oithona plumifera* Baird, 1843

*Oithona plumifera*. —Giesbrecht, 1892, p. 537, pl. 34, figs 12–13, 22, 25, 27–29, 32–33, 44–47, pl. 44, figs 1, 7, 12–15.

OCCURRENCE. Stn P6, 23 Jan., 1975, 2 females; Stn P10, 22 Oct., 1976, 1 female.

*Oithona similis* Claus, 1866

*Oithona similis* Claus, 1866, p. 14. —Giesbrecht, 1892, p. 537, pl. 34, figs 18, 19, 21, 36–39, pl. 44, figs 3, 5, 8–11.

OCCURRENCE. See Fig. 8.

*Oithona nana* Giesbrecht, 1892

*Oithona nana* Giesbrecht, 1892, p. 538, pl. 34, figs 10–11, 20, 24, 34–35, 42, pl. 44, figs 2, 4, 6.

OCCURRENCE. See Fig. 8.

*Oithona aruensis* Früchtl, 1923

*Oithona brevicornis* f. *aruensis* Früchtl, 1923, p. 454; 1924, p. 88, figs 44 (1)–(2), table 7.
*Oithona aruensis*. —Nishida & Ferrari, 1983, p. 74, figs 2–5.

OCCURRENCE. See Fig. 7.

*Remarks.* The detailed description of *O. aruensis*, the diagnosis of this species and closely allied *O. brevicornis* and *O. wellershausi*, and related synonymies are given in Ferrari (1981) and Nishida & Ferrari (1983).

*Oithona attenuata* Farran, 1913

*Oithona attenuata* Farran, 1913, p. 187, pl. 30, figs 3–7.

OCCURRENCE: Stn P6, 23 Jan., 1975, 1 female.

*Oithona oculata* Farran, 1913

*Oithona oculata* Farran, 1913, p. 188, pl. 30, fig 8–9, pl. 31, figs 2–9.

OCCURRENCE: See Fig. 8.

*Oithona simplex* Farran, 1913

*Oithona simplex* Farran, 1913, p. 187, pl. 29, figs 10–14, pl. 30, figs 1–2.

OCCURRENCE. See Fig. 7.

*Oithona dissimilis* Lindberg, 1940

*Oithona dissimilis* Lindberg, 1940, p. 520, fig. 2. —Ferrari, 1977, p. 400, figs 1A–G, 2A–E, 3A–B.
*Oithona dissimilis oceanica* Lindberg, 1947, p. 52, figs 2a–j.
*Oithona hebes* Giesbrecht. —Wellershaus, 1969, p. 276, figs 88–102.

OCCURRENCE. See Fig. 8.

*Remarks.* This is the first record of *O. dissimilis* in Japan and the northernmost record in the Pacific.

Order Poecilostomatoida

Family Oncaeidae

*Oncaea* spp.

OCCURRENCE. Stns P2, P3, P6, P8, 23 Jan., 1975, 26 specimens; Stns P8, P10, P11, 22 Oct., 1976, 19 specimens.

Family Corycaeidae

*Corycaeus* spp.

OCCURRENCE. Stn P3, 23 Jan., 1975, 1 specimen; Stns P6, P8, P9, P10, 22 Oct., 1976, 4 specimens.

Order Harpacticoida

Family Ectinosomatidae

*Microsetella rosea* (Dana, 1848)

*Harpacticus roseus* Dana, 1848, p. 153.
*Microsetella rosea.* —Giesbrecht, 1892, p. 550, pl. 44, figs 32, 35, 37, 38, 41, 43, 46, 48, 49.

OCCURRENCE. Stn P12, 9 June, 1975, 2 females.

## Distribution of the Major Copepod Species

Table 1 shows the order of abundance of the dominant copepods in the

embayment. In all three months, the copepod fauna in Kabira Bay was dominated by the three genera, *Paracalanus, Acartia* and *Oithona,* which accounted for more than 90% of the total number of copepods. Distribution of the major copepod species is shown in Figs. 7–8.

*Paracalanus crassirostris* was the most abundant species; its maximum density reached 25000/m$^3$ in January and June. In these months the density was highest in

Table 1. Major copepod species in Kabira Bay.
The figures in the parentheses indicate the percentage of each species of the total number of copepods (combined mean of Stns P2, P3, P4 and P6)

| Jan., 1975 | June, 1975 | Oct., 1976 |
|---|---|---|
| *Paracalanus crassirostris* (92.2) | *O. aruensis* (48.1) | *P. crassirostris* (55.1) |
| *Acartia erythraea* (4.5) | *P. crassirostris* (44.3) | *O. simplex* (27.1) |
| *Oithona aruensis* (1.6) | *O. simplex* (5.5) | *O. aruensis* (12.4) |
| *Acartia steueri* (0.5) | *A. fossae* (0.9) | *O. dissimilis* (2.2) |
| *Oithona dissimilis* (0.3) | *O. oculata* (0.4) | |

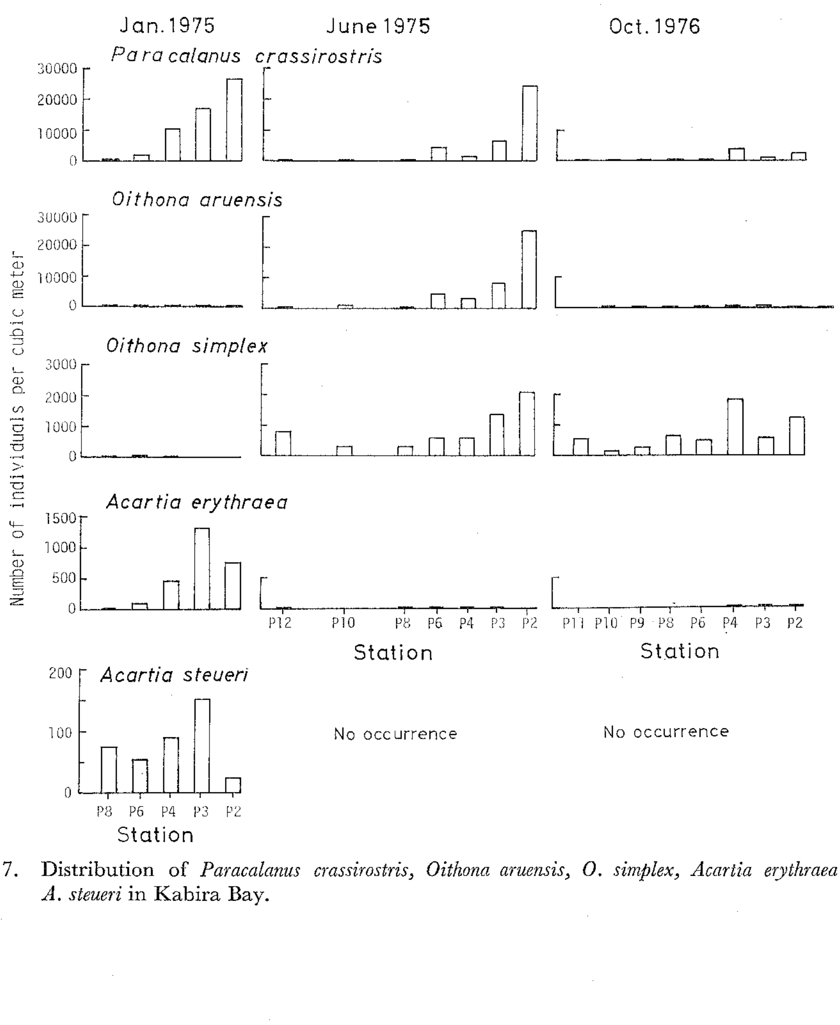


Fig. 7. Distribution of *Paracalanus crassirostris, Oithona aruensis, O. simplex, Acartia erythraea* and *A. steueri* in Kabira Bay.

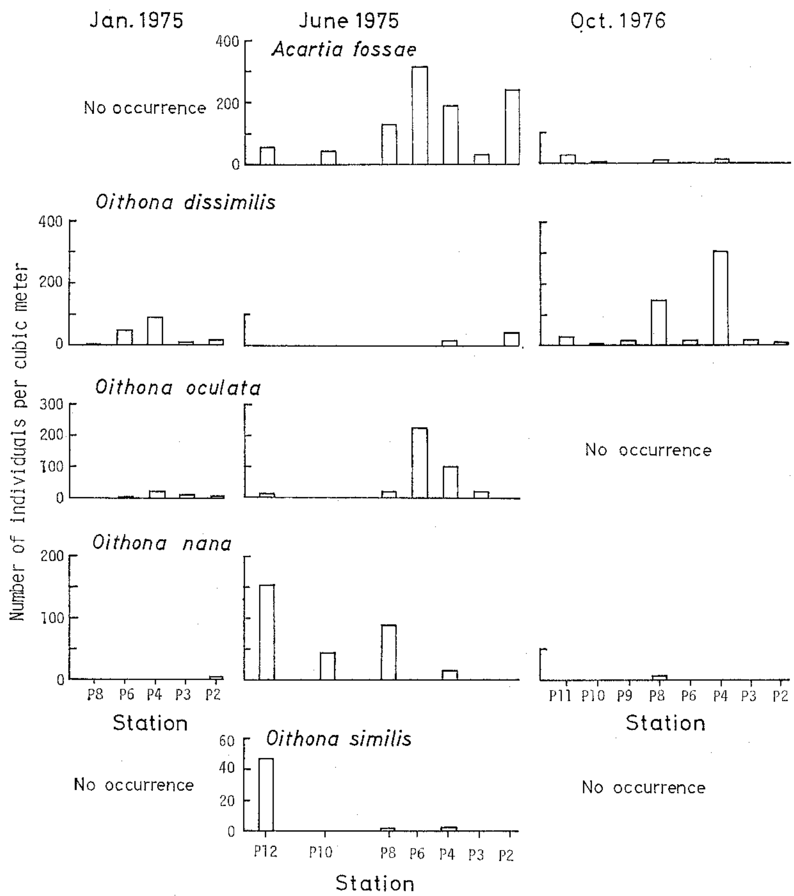


Fig. 8. Distribution of *Acartia fossae, Oithona dissimilis, O. oculata, O. nana* and *O. similis* in Kabira Bay.

the innermost part of the bay. In October when the density was much lower than in the other two months, the decrease of density from the inner to the outer stations was less marked.

*Oithona aruensis* was abundant in June, making up 48% of the total copepods, but was scarce in January and October. The pattern of distribution of *O. aruensis* resembles that of *P. crassirostris*. In June when *O. aruensis* was abundant, its density increased markedly from the outer to the innermost stations, whereas the differences of densities among stations were small in January and October.

*Oithona simplex* was abundant in June and October, but was scarce in January. Although this species had its center of distribution in the inner part of the bay, the difference of densities between the inside and outside of the bay was smaller than in *P. crassirostris* and *O. aruensis*.

*Acartia erythraea* was abundant in January, the highest density being $1300/m^3$. Though it occurred in higher densities in the embayment than in the waterway and outside the bay, unlike *P. crassirostris* and *O. aruensis*, the density decreased from Stn

P3 to the innermost Stn P2.

*Acartia steueri* occurred in January, *A. fossae* in June and October, and *O. dissimilis* in all the three months, though in low densities. These three species did not show any characteristic patterns of distribution except that they were more abundant in the embayment than in the waterway and outside the bay.

*Oithona oculata* occurred in low densities in January and June, showing a tendency to increase in the center of the embayment.

*Oithona nana* and *O. similis* showed high densities outside the bay in June, decreasing through the waterway towards the embayment. In the other two months, these two species and *O. plumifera* and *O. attenuata* occurred in low densities only in the waterway and/or outside the bay.

## Discussion

In Japanese embaymental waters north of Kyushu, *Acartia clausi, Paracalanus parvus* and *Oithona aruensis* are among the most abundant pelagic copeods (Yamazi, 1956; Hirota & Hara, 1975; Itoh & Iizuka, 1979; Ueda, 1980, etc.). In Kabira Bay, however, only *O. aruensis* of these three species occurred in significant numbers; the other two species were not collected in the present study, except for a single specimen which resembles *P. parvus* (*P.* sp.). The paracalanid fauna in Kabira Bay is characterized by the dominance of *Paracalanus crassirostris*, while the acartiid fauna is characterized by the alternate occurrence of *A. steueri, A. fossae* and *A. bispinosa*; the latter two species have not been reported north of Kyushu. The number of the species of neritic *Oithona* is also larger in Kabira Bay than in the northern waters owing to the co-occurrence of *O. simplex* and *O. dissimilis* with *O. aruensis* and *O. oculata*; only the latter two are the typical neritic species in the waters north of Kyushu (Itoh & Iizuka, 1979; Ueda, 1980). Thus, the copepod fauna in Kabira Bay differs from that in the embaymental waters of Japan north of Kyushu in having a different species composition and larger number of species, showing a characteristic of the equatorial-neritic waters.

Hydrographically, Kabira Bay is under a strong influence of the oceanic water introduced into the bay, although it is isolated from the open sea by the wide fringing reef with the exception of a narrow waterway; about 68% of the bay water is estimated to be exchanged with the water outside the bay in 4.5 days (Horikoshi, 1979). In the present study, however, a great abundance of several species which are known to proliferate in embaymental conditions was observed in the inner part of the bay.

The pelagic copepods in Kabira Bay can be divided into three groups according to their patterns of distribution: (1) species which are distributed pirncipally in the embayment and whose density increases towards the innermost part (*P. crassirostris, O. aruensis*); (2) species which are distributed principally in the waterway and outside the bay and are almost absent in the embayment (*O. similis, O. nana*); (3) species which are abundant in the embayment but do not show significant increase

of density in the innermost part (*A. erythraea, A. steueri, A. fossae, O. simplex, O. oculata, O. dissimilis*). The existence of the distribution pattern shown by Group-(1) indicates that the hydrographic condition in the innermost part of Kabira Bay, in spite of the strong oceanic inflow, is appropriate for the maintenance of the population of the neritic species, while that shown by Group-(2) indicates that the individuals of the oceanic species introduced into the embayment are numerically insignificant as members of the embaymental zooplankton community and presumably cannot reproduce in the inner part of the bay.

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*Notes added in proof*: For recent information of the taxonomic problems in *Oithona aruensis* and related species in Japan, see Nishida et al. (1977), Nishida & Ferrari (1983) and Nishida (in press).

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